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Evaluation of the Rainbow Trout Stocking Program for Piledriver Slough, 1991

by

L. Saree Timmons

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ABSTRACT

Survival of rainbow trout *Oncorhynchus mykiss* stocked in 1990 in Piledriver Slough was estimated to be 0.021 (standard error = 0.004). Growth of rainbow trout tagged in 1990 and recaptured in 1991 averaged 30 millimeters. Abundance of all rainbow trout larger than 149 millimeters in Piledriver Slough in May 1991 was estimated to be 651 fish (standard error = 78). Gravid females made up 11.6% (standard error = 2.8) of the rainbow trout population in May 1991 with males accounting for 41.9%, non-gravid females accounting for 34.9%, and fish for which sex could not be determined accounting for the remaining 11.6% of the population. No young-of-the-year rainbow trout were captured in Piledriver Slough during 1991. Of the 25,143 triploid rainbow trout stocked in Piledriver Slough in 1991, an estimated 9,048 (standard error = 678) were catchable-sized and the 1991 stocking was not cost effective.

KEY WORDS: rainbow trout, *Oncorhynchus mykiss*, stocking evaluation, Piledriver Slough, Tanana River, survival, reproduction.

INTRODUCTION

Piledriver Slough, a clear-water stream located near Fairbanks, Alaska, was chosen as the location for an experimental stocking program of rainbow trout *Oncorhynchus mykiss* that took place annually from 1987 through 1991 by the Alaska Department of Fish and Game (ADFG). The purpose of the program was to determine if a viable sport fishery for rainbow trout could be established in Piledriver Slough and to determine the best strategy for stocking rainbow trout in these flowing waters of interior Alaska. In 1990, an evaluation of the program showed that after initiation of the rainbow trout stocking, Piledriver Slough quickly became one of the most popular sport fishing locations in interior Alaska in terms of effort and harvest of rainbow trout (Table 1). Growth and survival of rainbow trout stocked in Piledriver Slough were generally low, and only rainbow trout stocked as catchables contributed significantly to the fishery. Although few gravid females were found, it could not be determined conclusively if age 0 (young-of-the-year) rainbow trout resulting from natural reproduction were present in the slough, because fingerlings had been stocked there as recently as 1989 (Timmons 1991). Objectives of the 1991 study, which were aimed at completing the evaluation, were to:

1. estimate survival rate of 1990 catchable rainbow trout, from time of stocking to May 1991; and,

2. document the presence or absence of age 0 rainbow trout fingerlings in Piledriver Slough.

METHODS

Study Design and Data Collection

To determine the survival rate of rainbow trout stocked in 1990, abundance of rainbow trout was first estimated in May 1991 by the Petersen single-season mark-recapture method (Seber 1982). The study area was stratified into two sections: upper Piledriver Slough along Stringer Road (sites 1-5) and lower Piledriver Slough (sites 6-20; Figure 1). Rainbow trout were captured from each stratum during a mark event (May 6-9) and a recapture event (May 13-16).

One pass of Piledriver Slough was made during each sampling event using backpack electroshockers. Captured rainbow trout were measured to the nearest mm fork length (FL), spawning condition and sex were noted when determinable, and fin clips were noted. Prior to their introduction into Piledriver Slough, all rainbow trout stocked in 1990 were given an adipose fin clip. During 1990 field sampling, all tagged rainbow trout were given an upper caudal fin clip. In 1991, all rainbow trout larger than 149 mm were double marked with an individually numbered Floy anchor tag and a lower caudal fin clip. The tags of rainbow trout recaptured from 1990 were noted and those rainbow trout were also given a lower caudal fin clip. Although all rainbow trout larger than 149 mm were marked, only those with adipose clips were used for the survival estimate. Rainbow trout were sacrificed if sex could not be determined in the field (up to the required sample size of 254). The sacrificed fish were

Table 1. Effort and harvest of rainbow trout at Piledriver Slough and in the Tanana drainage, 1983-1990.

	Piledriver Slough				Tanana Drainage		% of Tanana Drainage[g]	
Year	Number of Anglers	Number of Trips	Days Fished	Harvest of Rainbow Trout	Days Fished	Rainbow Trout Harvest	Days Fished	Rainbow Trout Harvest
1983[a]			4,148	0	146,386	20,664	2.8	0
1984[b]	470	2,334	4,651	0	145,752	34,022	3.2	0
1985[b]	648	3,019	2,133	0	136,422	33,432	1.6	0
1986[b]	342	1,870	2,079	0	144,937	31,270	1.4	0
1987[c]	4,686	15,236	13,247	4,346	156,061	31,824	8.5	13.7
1988[d]	4,981	21,936	24,375	12,296	174,554	78,345	14.0	15.7
1989[e]	5,268	19,512	22,746	7,689	186,418	74,675	12.2	10.3
1990[f]	6,313	23,024	27,705	8,052	184,887	64,143	15.0	12.5

[a] Mills 1984.
[b] Mills, unpublished data.
[c] Mills 1988.
[d] Mills 1989.
[e] Mills 1990.
[f] Mills 1991.
[g] Percent of Tanana drainage fishery represented by Piledriver Slough.

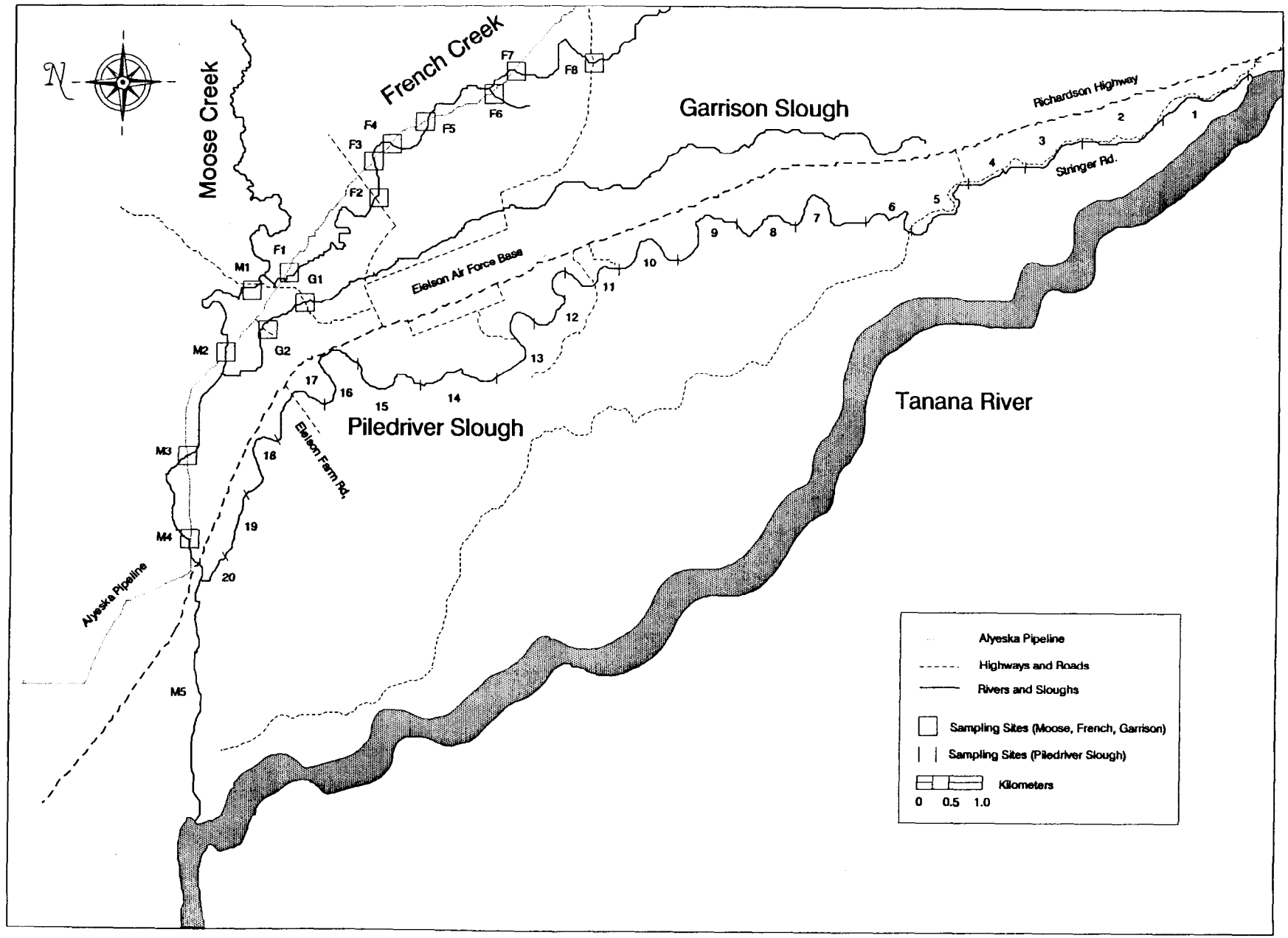

Figure 1. Study sites on Piledriver Slough, Moose Creek, French Creek, and Garrison Slough.

preserved by freezing, and autopsied at a later date. Rainbow trout were sampled for sex determination without regard to fin clips. Upon autopsy, rainbow trout were categorized as sex unknown, male, female-gravid, or female-not gravid. During August 20-23, 1991, one pass of Piledriver Slough was again made with backpack electroshockers. Captured rainbow trout were measured and inspected for tags and fin clips, but were not tagged.

To document the presence or absence of young-of-the-year (YOY) rainbow trout, Piledriver Slough was sampled with baited minnow traps and beach seines. On June 25, 100 minnow traps were set throughout Piledriver Slough: (1) 61 traps in sites 1-5; (2) 11 traps in site 10; (3) 12 traps in site 13; (4) 10 traps in site 17; and, (5) 6 traps in 23-mile Slough. The minnow traps were checked and re-set on June 26, and checked a second time and removed on June 27. Minnow traps were set in French Creek, Moose Creek, and Garrison Slough on July 30, and checked and removed on August 1 (Figure 2). At each of Piledriver Slough sites 1 and 3-7, Moose Creek sites 1-5, and Garrison Slough sites 1-2, four traps were set. Six traps were set at each of Piledriver Slough sites 9-14. On August 13, 27 seine hauls were made throughout Piledriver Slough, from site 2 through site 17.

Three stockings, of 6,568, 6,525, and 12,050 triploid rainbow trout, took place in 1991 on May 17, June 11, and July 15, respectively. Each time, rainbow trout were released at three locations: site 5 (Stringer Road culverts), site 11 (Bailey Bridge), and site 17 (Eielson Farm Road culverts). A portion of rainbow trout from each stocking were measured, and scales were collected for historical archives. Scales were taken from an area on the fish above the lateral line just posterior to the insertion of the dorsal fin.

Data Analysis

In 1991, the Bailey modification of the Petersen single-mark method was used to estimate the abundance of adipose-clipped rainbow trout in Piledriver Slough (Seber 1982):

$$\hat{N} = \frac{M(C+1)}{(R+1)}; \text{ and,} \qquad (1)$$

$$\hat{V}[N] = \frac{\hat{N}^2(C-R)}{(C+1)(R+2)}; \qquad (2)$$

where:

M = number of rainbow trout marked during the marking event;

C = number of rainbow trout captured during the recapture event; and,

R = number of rainbow trout recaptured during the recapture event.

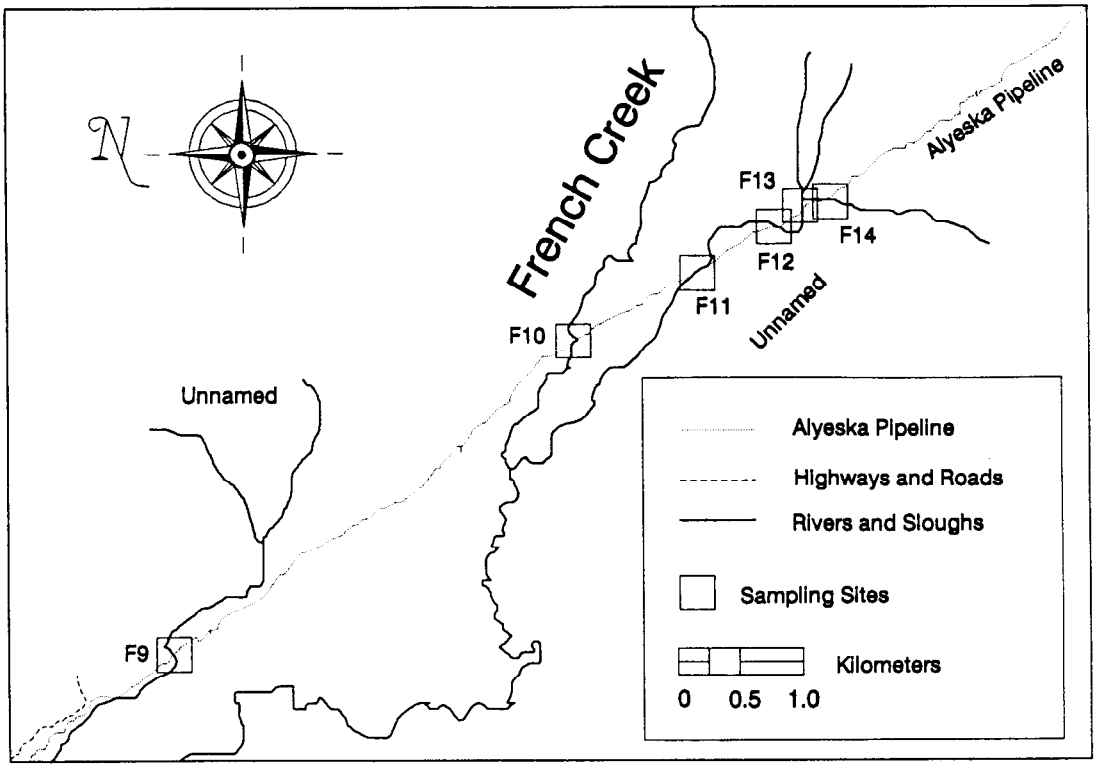

Figure 2. Study sites on upper French Creek.

Rainbow trout sacrificed during the mark event were added to the Petersen estimate to obtain a final estimate of abundance just prior to the mark event. Conditions for the accurate use of the Petersen single-mark method are:

1. marking does not affect the catchability of rainbow trout;

2. marked rainbow trout do not lose their marks between sampling events;

3. recruitment *and* death of rainbow trout do not occur between sampling events; and,

4. every rainbow trout has an equal probability of being marked and released alive during the first sampling event; *or* every rainbow trout has an equal probability of being captured during the second sampling event; *or* marked rainbow trout mix completely with unmarked rainbow trout between sampling events (Seber 1982).

Double marking with the fin clip permitted correction of abundance estimates for any tag loss that may have occurred. Recruitment of rainbow trout in Piledriver Slough comes exclusively from stocking, and because stocking did not occur until after the experiment was completed, recruitment did not occur during the experiment. Two contingency table analyses were used to determine if condition 4 had been met (Seber 1982). A chi-square test, which compared the recapture to catch ratios (by area strata), tested for complete mixing of rainbow trout or that every rainbow trout had the same probability of being tagged during the marking event. The second contingency table, which compared numbers (by area strata) of rainbow trout released, recaptured, and not recaptured, was employed to detect mixing of rainbow trout among area strata. To detect size-selectivity during the mark and recapture events, two Kolmogorov-Smirnov tests were conducted. The outcome of the tests determined whether the estimates of abundance were stratified by size and from which event age and length data were to be used.

Survival rate (S) of rainbow trout stocked in 1990 and its variance (V[S]) were estimated by the equations:

$$\hat{S} = \frac{\hat{N}}{\text{number stocked in 1990}}; \text{ and,} \quad (3)$$

$$\hat{V}[S] = \hat{V}[N] \cdot (1/\text{number stocked in 1990})^2. \quad (4)$$

To estimate length compositions, rainbow trout were grouped by 10 mm length categories. Length compositions were considered a series of proportions, one for each length group, whose sum was one. Length compositions were calculated according to the equations:

$$\hat{p}_i = \frac{y_i}{n}; \text{ and,} \quad (5)$$

$$\hat{V}[\hat{p}_i] = \frac{\hat{p}_i(1-\hat{p}_i)}{n-1}. \quad (6)$$

where:

$\hat{p}_i$ = the estimated proportion of rainbow trout of length group i in the population;

y_i = the number of rainbow trout of length group i in the sample;

n = the number of rainbow trout in the sample; and,

$\hat{V}[\hat{p}_i]$ = the variance of the estimated proportion of rainbow trout of length group i in the population.

Sex compositions were also considered a series of proportions and were estimated with Equations 5 and 6, with sex substituted for length group. The number of rainbow trout of catchable size (N_c) in a particular stocking in 1991 was also estimated:

$$\hat{N}_c = \hat{p}_c \cdot N_s \quad (7)$$

$$\hat{V}[\hat{N}_c] = N_s^2 \cdot \hat{V}[\hat{p}_c] \quad (8)$$

where:

$\hat{p}_c$ = the estimated proportion of stocked rainbow trout that were of catchable size ($\geq$200 mm FL); and,

N_s = the number of stocked rainbow trout that were of catchable size.

Estimated proportions ($\hat{p}_c$) and their variances were calculated using Equations 5 and 6. Calculations were repeated for fish released in June and in July. The estimates of the number of rainbow trout of catchable size that were stocked in each month were then summed for the total number of catchable-sized rainbow trout that were stocked in 1991. The variance was calculated by summing the variances for each month. The numbers of rainbow trout released were treated as constants, although these numbers were actually estimated based on the average weight of the stocked rainbow trout.

RESULTS

Survival rate of rainbow trout stocked in 1990, from June 1990 to May 1991 was estimated to be 0.021 (SE = 0.004). Abundance of the 1990 stocking cohort in May 1991 was estimated to be 538 rainbow trout (SE = 71). In 1990, 20,000 rainbow trout were stocked. During the mark event, 84 rainbow trout were released with tags, and 141 were examined during the recapture event, of which

27 were recaptures. During the mark event, 112 rainbow trout with adipose clips were sacrificed to determine sex. Every rainbow trout had the same probability of being tagged during the mark event, or tagged and untagged rainbow trout mixed completely between events ($\chi^2 = 2.05$, df = 1, $P = 0.15$; Table 2); mixing of rainbow trout between upper and lower Piledriver Slough was partial (Table 3). Size-selective sampling during the mark and recapture events was not detected; lengths of rainbow trout marked were not significantly different from lengths of rainbow trout recaptured (DN = 0.14, $P = 0.82$), and lengths of rainbow trout marked were not significantly different from lengths of rainbow trout captured during the recapture event (DN = 0.12, $P = 0.44$). Growth of rainbow trout tagged in April, May, or June of 1990 and recaptured in May of 1991, averaged 30 mm, ranging from 5 mm to 54 mm (Table 4).

Abundance of all rainbow trout larger than 149 mm in Piledriver Slough in May 1991 was estimated to be 651 (SE = 78). During the mark event, 106 rainbow trout were released with tags, and of the 171 examined during the recapture event, 34 were recaptures. During the mark event, 130 rainbow trout (with and without adipose clips) were sacrificed. Every rainbow trout had the same probability of being tagged during the mark event, or tagged and untagged rainbow trout mixed between events ($\chi^2 = 1.25$, df = 1, $P = 0.26$; Table 5); rainbow trout mixed partially between upper and lower Piledriver Slough (Table 6). Results of the two Kolmogorov-Smirnov tests indicated that size-selective sampling did not occur during either event (DN = 0.14, $P = 0.62$ for lengths of rainbow trout marked compared to lengths of rainbow trout recaptured; DN = 0.09, $P = 0.65$ for lengths of rainbow trout marked compared to lengths of rainbow trout captured).

Gravid females made up 11.6% (SE = 2.8) of the rainbow trout population in May 1991; mean length of gravid females was 221 mm (Table 7). No YOY rainbow trout were captured in Piledriver Slough during 1991. No YOY rainbow trout were captured during the August electrofishing. No YOY rainbow trout were captured in minnow traps in Piledriver Slough, nor were they captured in Moose Creek, French Creek, or Garrison Slough, but minnow traps were not very successful at capturing any species of fish (only 10 Arctic grayling *Thymallus arcticus* and 28 slimy sculpin *Cottus cognatus* were captured with the minnow traps in Piledriver Slough). No rainbow trout were captured with seines, although 470 YOY Arctic grayling, numerous longnose suckers *Catostomus catostomus*, numerous round whitefish *Prosopium cylindraceum*, and 78 slimy sculpin were captured with seines.

Of the 25,143 triploid rainbow trout stocked in Piledriver Slough in 1991, an estimated 9,048 (SE = 678) were larger than 199 mm. Of the rainbow trout stocked in May, only 12.5% (SE = 3.0%) were larger than 199 mm, 21.6% (SE = 3.9%) in the June stocking were larger than 199 mm, and in the July stocking, 56.6% (SE = 4.9%) were larger than 199 mm. The length distribution of rainbow stocked in May was not significantly different from that in June (Kolmogorov-Smirnov test, DN = 0.14, $P = 0.24$), but the June stocking was significantly different from the July stocking (Kolmogorov-Smirnov test, DN = 0.43, $P < 0.01$; Table 8; Figure 3). Of the 452 rainbow trout captured in the May electrofishing, 69.0% (SE = 2.2) had adipose clips and 31.0% (SE = 2.2) did not have adipose clips. In August, 597 rainbow trout were

Table 2. Numbers of marked and unmarked rainbow trout examined during the recapture event in 1991 (adipose clipped only).[a]

	Area of Capture		
	Upper Piledriver	Lower Piledriver	Total
Marked	19	8	27
Unmarked	63	51	114
Total	82	59	141

[a] $\chi^2 = 2.05$, df = 1, $P = 0.15$

Table 3. Numbers of rainbow trout marked and recaptured in upper and lower Piledriver Slough in 1991 (adipose clipped only).

Area Released	Area Recaptured: Upper Piledriver	Area Recaptured: Lower Piledriver	Total Recaptured	Number Not Recaptured	Total Released
Upper Piledriver	14	0	14	16	30
Lower Piledriver	5	8	13	41	54
Total	19	8	27	57	84

Table 4. Growth of rainbow trout tagged in 1990 and recaptured in May 1991.

Tag Number	Date Tagged (1990)	Length at Tagging (mm)	Date Recaptured (1991)	Length at Recapture (mm)	Growth (mm) from 1990-1991
80026	April 25	193	May 7	241	48
80201	May 2	210	May 9	253	43
80958	June 26	213	May 14	267	54
81878	June 20	255	May 6	260	5
81894	June 21	168	May 6	198	30
82265	June 20	194	May 6	207	13
83739	May 4	206	May 7	222	16
Average Growth					30

Table 5. Numbers of marked and unmarked rainbow trout examined during the recapture event in 1991 (all over 149 mm).[a]

	Area of Capture		
	Upper Piledriver	Lower Piledriver	Total
Marked	21	13	34
Unmarked	70	67	137
Total	91	80	171

[a] $\chi^2 = 1.25$, df = 1, $P = 0.26$

Table 6. Numbers of rainbow trout marked and recaptured in upper and lower Piledriver Slough 1991 (all over 149 mm).

Area Released	Area Recaptured: Upper Piledriver	Area Recaptured: Lower Piledriver	Total Recaptured	Number Not Recaptured	Total Released
Upper Piledriver	16	1	17	17	34
Lower Piledriver	5	12	17	55	72
Total	21	13	34	72	106

Table 7. Sex composition of rainbow trout sampled in Piledriver Slough, 1991.

Sexual Characteristic	Percent of Total[a]	n	Mean Length (mm FL)
Unknown	11.6 (4.7)	15	176 (5)
Male	41.9 (4.1)	54	212 (4)
Non-Gravid Female	34.9 (4.2)	45	202 (6)
Gravid Female	11.6 (2.8)	15	221 (6)
All Females	46.5 (4.4)	60	207 (3)
Total	100.0	129	

[a] SE's in parentheses.

Table 8. Length composition of rainbow trout stocked in Piledriver Slough in 1991.

	May		June		July	
Length (mm FL)	Number	Percent	Number	Percent	Number	Percent
90-99	0	0.0	2	1.8	0	0.0
100-109	0	0.0	0	0.0	0	0.0
110-119	1	0.8	3	2.7	1	1.0
120-129	6	5.0	2	1.8	0	0.0
130-139	7	5.8	6	5.4	3	3.0
140-149	12	10.0	10	9.0	6	6.1
150-159	14	11.7	12	10.8	1	1.0
160-169	17	14.2	10	9.0	8	8.1
170-179	18	15.0	14	12.6	6	6.1
180-189	17	14.2	18	16.2	8	8.1
190-199	13	10.8	10	9.0	10	10.1
200-209	7	5.8	16	14.4	16	16.2
210-219	5	4.2	2	1.8	12	12.1
220-229	1	0.8	4	3.6	9	9.1
230-239	0	0.0	2	1.8	8	8.1
240-249	1	0.8	0	0.0	7	7.1
250-259	0	0.0	0	0.0	3	3.0
>259	1	0.8	0	0.0	1	1.0
Total	120	100.0	111	100.0	99	100.0
Mean Length	171		173		200	
SE	3		3		3	

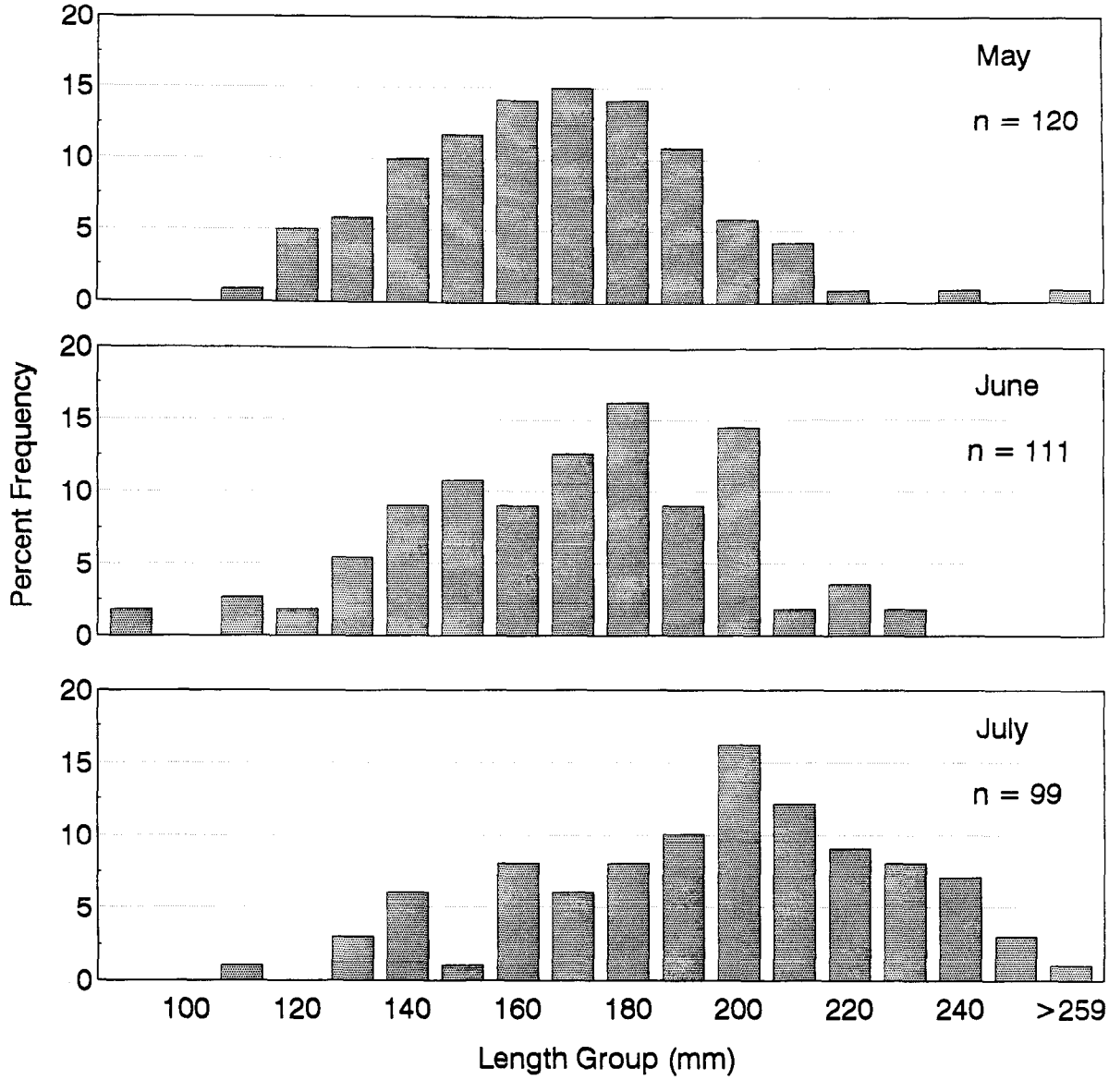

Figure 3. Length distributions of rainbow trout stocked in Piledriver Slough in May, June, and July, 1991.

sampled, of which 14.9% (SE = 1.5) had adipose clips and 85.1% (SE = 1.5) did not have adipose clips. Length distributions of adipose clipped and non-adipose clipped rainbow trout were significantly different in May (Kolmogorov-Smirnov test, DN = 0.59, $P < 0.01$) but distributions were not significantly different in August (DN = 0.15, $P = 0.08$; Figure 4).

Fishing effort (days fished) at Piledriver Slough was positively correlated to the number of catchable rainbow trout stocked from 1984 through 1990, ($R^2 = 0.91$, a = 3,332, b = 0.87; Figure 5). The proportion of successful anglers (those catching three or more rainbow trout, Timmons 1991) remained low throughout the summer, until July 20 and July 27 when over 40% of anglers were successful (Hallberg and Bingham *In prep*; Figure 6).

DISCUSSION

Stocking triploid rainbow trout in Piledriver Slough may not be necessary in the future. Triploids were stocked to eliminate natural reproduction of rainbow trout in Piledriver Slough, but all available information indicates that rainbow trout do not reproduce in Piledriver Slough. Because of low survival and growth rates, few rainbow trout are available for spawning the spring after they are stocked, and few of the surviving females are gravid. The absence of YOY rainbow trout further supports the lack of natural reproduction in Piledriver Slough. Because only rainbow trout stocked as catchables contribute to the Piledriver Slough fishery (Timmons 1991), it is important to insure that the fish that are stocked are of adequate size. The triploids stocked in 1991, of which only one-third were catchable size, was likely not cost effective.

Fishing effort in the sport fishery and stocking level were positively correlated. A very strong linear relationship between effort (days fished) and stocking level, with $R^2 = 0.99$, was also reported by Timmons (1991) for the years 1986-1989. Including 1990 data in the linear regression resulted in a slightly poorer fit ($R^2 = 0.91$), because the number of catchable rainbow trout stocked decreased from 1989 to 1990, while effort increased by 18%. The proportion of successful anglers remained low until the third stocking, due to the low proportion of catchable-sized rainbow trout in the May and June stockings.

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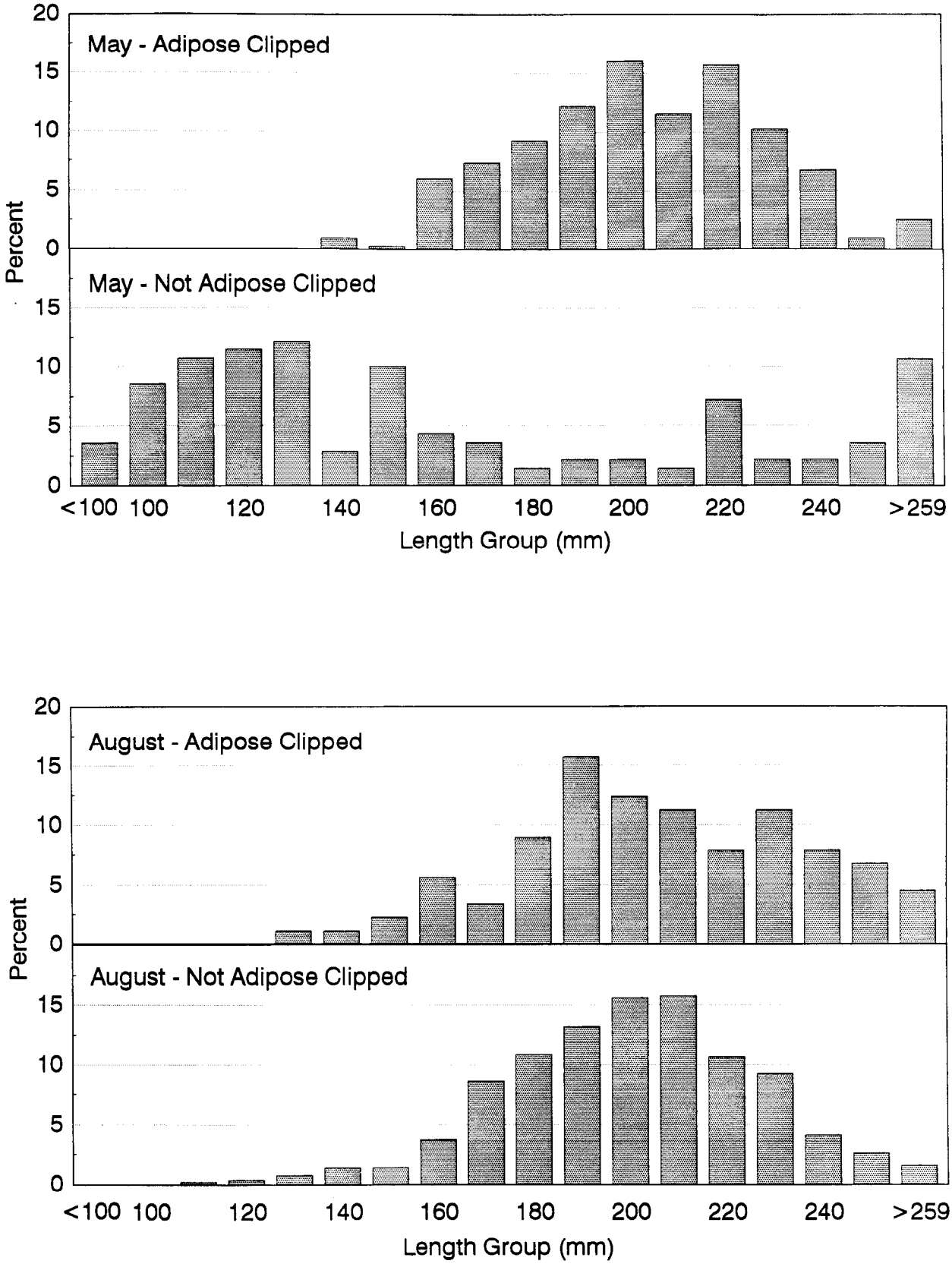

Figure 4. Length distributions of clipped and non-clipped rainbow trout captured in Piledriver Slough in May and August, 1991.

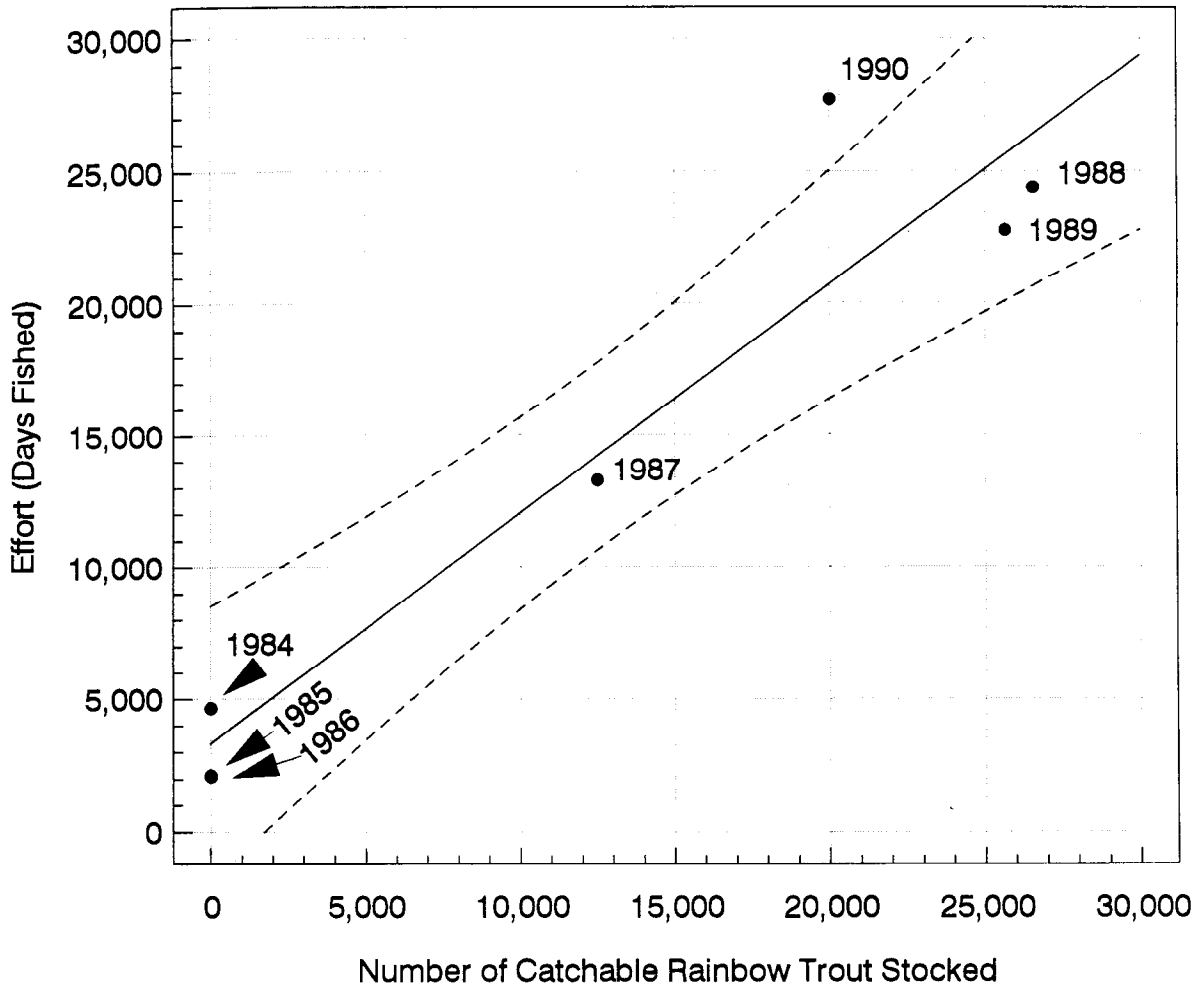

Figure 5. Relationship between number of catchable-sized rainbow trout stocked, and effort (days fished) at Piledriver Slough, 1984-1990.

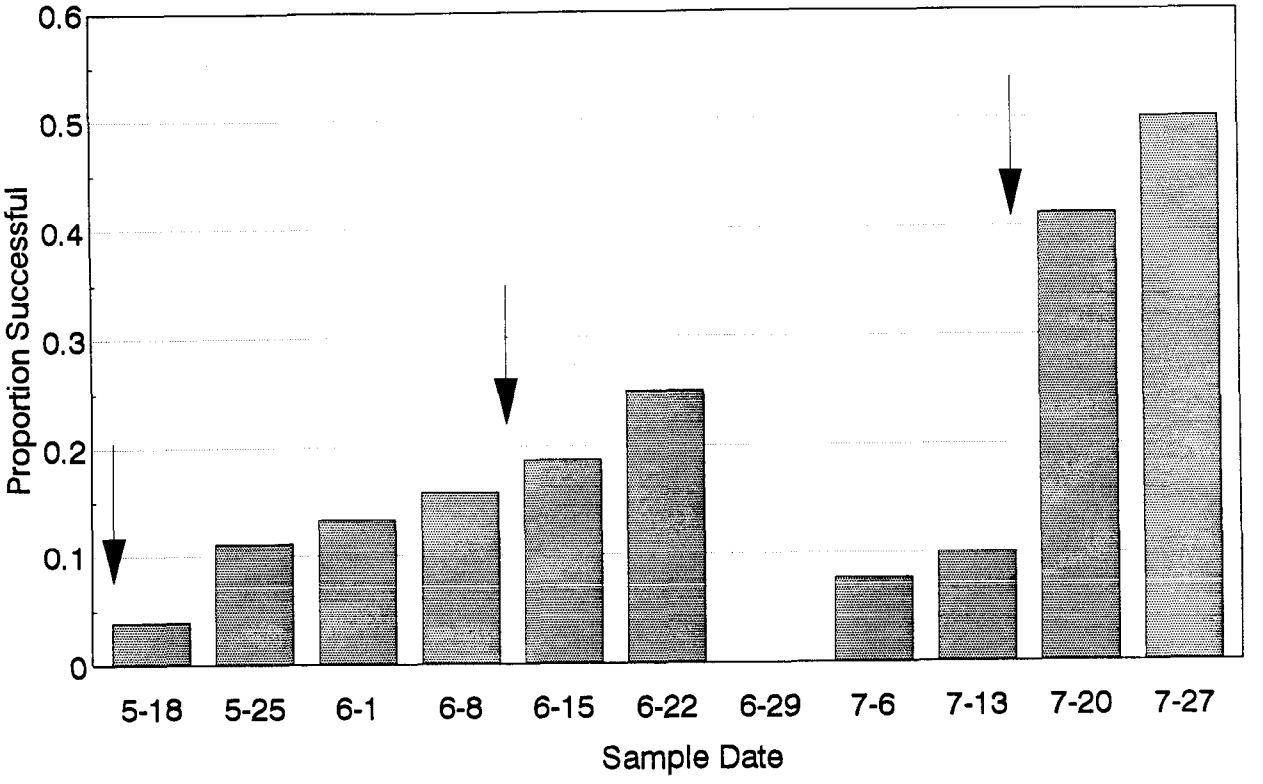

Figure 6. Proportion of anglers catching three or more rainbow trout, by date in 1991. Arrows indicate stockings.

LITERATURE CITED

Hallberg, J. and A. Bingham. *In prep.* Creel surveys conducted in interior Alaska during 1991. Alaska Department of Fish and Game, Fishery Data Series.

Mills, M. J. 1984. Alaska statewide sport fish harvest studies (1983). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25 (SW-I-A). 123 pp.

_____. 1988. Alaska statewide sport fisheries harvest report. Alaska Department of Fish and Game, Fishery Data Series No. 52, Juneau.

_____. 1989. Alaska statewide sport fisheries harvest report. Alaska Department of Fish and Game, Fishery Data Series No. 122, Juneau.

_____. 1990. Harvest and participation in Alaska sport fisheries during 1989 (1990). Alaska Department of Fish and Game, Fishery Data Series No. 90-44, Anchorage.

_____. 1991. Harvest, catch, and participation in Alaska sport fisheries during 1990. Alaska statewide sport fisheries harvest report. Alaska Department of Fish and Game, Fishery Data Series No. 91-58, Anchorage.

Seber, G. A. 1982. The estimation of animal abundance and related parameters. 2nd ed. Charles Griffin and Company Limited, Charles Griffin House, Crendon Street, High Wycombe Bucks, HP13 6LE, England. 654 pp.

Timmons, L. S. 1991. Evaluation of the rainbow trout stocking program for Piledriver Slough. Alaska Department of Fish and Game, Fishery Data Series No. 91-25, Anchorage.